

A not so massive cluster hosting a very massive star

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We present the first physical characterization of the young open cluster VVV CL041. We spectroscopically observed the cluster main-sequence stellar population and a very-massive star candidate: WR62-2. CMFGEN modeling to our near-infrared spectra indicates that WR62-2 is a very luminous ($10^{6.4 \pm 0.2} L_{\odot}$) and massive ($\sim 80 M_{\odot}$) star.

The current census of Wolf-Rayet (WR) in the Milky Way is far from complete (for example, there are ~ 640 WR stars reported in the online “Galactic Wolf Rayet Catalogue”, but we expect over 1900 in our Galaxy; Rosslowe & Crowther 2015). It is also under debate the WR birth-place. We expect their formation in clustered environments, but it is unclear whether it happens in young clusters or associations. Trying to solve this question, we started a search of WR in the cluster candidates catalogue from Borissova et al. (2011), based on images from the ESO Public Survey VVV (Minniti et al. 2010)).

Using VVV JHK_S photometry and H -, K -band spectroscopy we determine the cluster distance (via spectroscopic parallax; $d = 4.2 \pm 0.9$ kpc), radius ($r = 0.75'$), age (fitting Geneva-MS and PMS isochrones, Ekström et al. 2012; Siess et al. 2000; age=1–5 Myr), and total stellar mass (by integration of Kroupa-IMF, Kroupa 2001, fitted to the cluster mass function; $M_{CL} = (3.1 \pm 0.6) \cdot 10^3 M_{\odot}$).

The near-IR spectra also revealed part of the cluster main sequence population. We observe 8 stars, and we classify 6 of them as OB-type stars (between O4 V and early B-type). Spectrum of star #8, the brightest star in the decontaminated CMD, displays the Brackett series with strong and broad emission lines. The CIV and NIII lines are clearly detected. The Brackett series in emission indicates that hydrogen is still present. Carbon lines are narrow and weak, confirming that it is not a WC. We assigned a spectral type WN8-9h to star #8 (hereafter, WR62-2).

Using the code CMFGEN (Hillier & Miller 1998), we estimate for WR62-2 the effective temperature ($T_{eff} = 34000 K$), which indicates a luminosity of ($10^{6.4 \pm 0.2} L_{\odot}$) and a initial mass of at least $80 M_{\odot}$, from the star position in the HR-diagram. The cluster and WR62-2 masses are incompatible with the ($M_{ecl} - m_{max}$) relation (Weidner et al. 2010). A binary merge is a probable mechanism to explain the presence of this very massive star in VVV CL041 and a gas remnant surrounding WR62-2 should be expected in mid-IR.

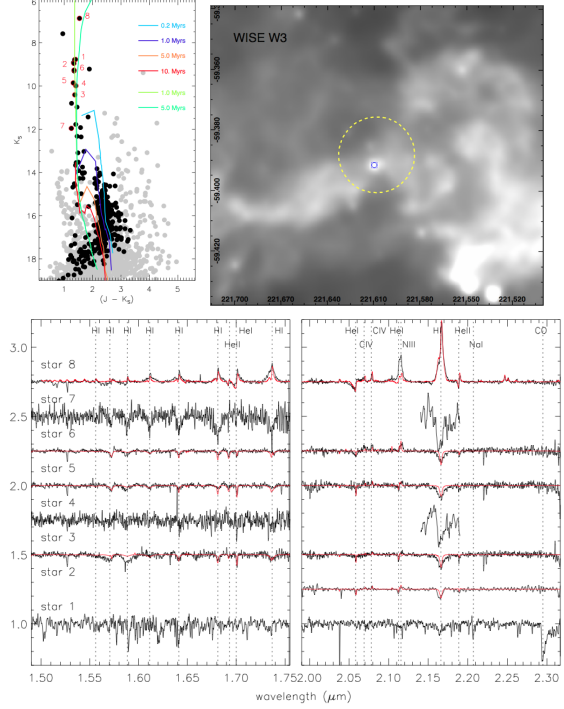


Fig. 1: *Top-left:* VVV CL041 field-star statistically decontaminated CMD. WR62-2 is shown on top of the cluster stellar population sequence. *Top-right:* VVV CL041 mid-IR WISE W3 image. The yellow circle and the blue square show the cluster’s and WR62-2 positions. *Bottom:* Near-IR stellar spectra (WR62-2 is shown on top). The CMFGEN models are shown with red lines.

References

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